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Social support and social strain in inter-episode bipolar disorder

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Abstract

Objectives—This study focused on social support and social strain and their cross-sectional associations with instabilities in sleep and social rhythms in inter-episode bipolar disorder (BD).

Methods—Thirty-five adults diagnosed with inter-episode BD type I and 38 healthy controls completed measures of perceived social support and social strain. Group differences in support and strain were examined. Within the BD group, instabilities in sleep and social rhythms were assessed with 28 days of daily diary and actigraphy. Correlation and regression analyses were used to examine cross-sectional and prospective associations between social support, social strain, instabilities in sleep and social rhythms, and mood symptoms.

Results—The BD group reported lower social support and higher social strain than the control group. Additionally, social strain was positively correlated with manic and depressive symptoms in the BD group. Furthermore, there was a cross-sectional association between social support and more stable sleep on actigraphy in the BD group, although social support did not predict future sleep instability.

Conclusions—These results indicate that inter-episode BD is associated with deficient social support and elevated social strain compared to controls, and that this may be due to persistent inter-episode mood symptoms. Social strain may be particularly important given its association withmanic and depressive symptoms. The results also raise the possibility that sleep instability is related to poor social support in BD.

Keywords

bipolar disorder; inter-episode; sleep; social rhythms; social strain; social support

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Bipolar disorder (BD) is a severe, chronic, and impairing psychiatric illness. It has an estimated lifetime prevalence of 3.9% (1) and is ranked in the top ten leading causes of disability worldwide by the World Health Organization. The inter-episode period of BD is defined by the absence of a clinical mood episode (i.e., no depression, mania, or hypomania is present), yet it is marked by depressive and / or manic symptoms more than 50% of the time (2, 3). The inter-episode period is also characterized by instabilities in sleep (4) and social rhythms (5), which likely increase the risk of relapse (6) and contribute to persistent interepisode symptoms and impairment (7). A number of calls have been made for research that will improve inter-episode quality of life through the identification of clinically relevant psychosocial factors (8). The present study aimed to further elucidate the role of two such factors, social support and social strain, during the inter-episode period of BD. In addition to characterizing impairments in social support and social strain, the present study focused on the association between these psychosocial factors and the persistent and impairing instabilities in sleep and social rhythms that are characteristic of BD.

Social support

Social support encompasses psychological and material resources provided by one's social network. Perceived social support (i.e., the subjective quality of social support) has been linked to well-being in healthy and medically ill individuals (9, 10) and has been found to be a stronger correlate of well-being than objective measures of support [e.g., the number of support providers (11)]. Greater perceived social support has also been found to promote recovery and prevent relapse in unipolar depressed individuals (12). Several lines of evidence suggest that social support may impact well-being and illness course in BD. For instance, lower levels of perceived social support have been found to predict depressive relapse (13, 14), while higher levels of social support have been theorized to reduce the risk of relapse, possibly by improving medication adherence (15).

These findings suggest that social support is an important psychosocial factor in BD. However, to the best of the authors' knowledge, only two studies have assessed whether social support is deficient during the inter-episode period of BD, and these have yielded inconsistent findings. While one study found a group of inter-episode BD women to have deficient social support compared to control women (16), the other found social support in inter-episode BD participants to be equivalent to that of controls (17). One possible explanation for this discrepancy is that while the former study used a measure of the perceived adequacy of social support, the latter used a measure that averages the amount of support (emotional, availability, and practical) received from the top five support providers. This second approach may decrease variability in scores. Additionally, by requiring individuals to identify five discrete support providers, this measure may serve more as a measure of objective support (e.g., number of adequate support providers) than perceived support. Given the small number of studies focused on social support in inter-episode BD and their mixed findings, additional research is needed to determine whether perceived social support is deficient during this phase of the illness. Furthermore, it is important to assess the extent to which social support may be related to inter-episode instabilities in sleep and social rhythms, as associations among these variables may yield insight into potential illness-maintaining mechanisms, and thus new targets for intervention.

Social strain

Social strain encompasses adverse social experiences (e.g., being criticized, ignored, overburdened) that cause one to have a negative reaction or concerns about one's relationships (18). Social strain has been found to be associated with depressive symptoms (19) and has been identified as a separate construct from life stress (20) and social support (21).

To the best of the authors' knowledge, social strain has not yet been investigated in BD. However, several studies have linked perceived criticism, a related construct, to symptoms in BD. For instance, greater distress generated by perceived criticism from friends / family is associated with an increased risk of depressive symptoms (22). Furthermore, an extensive body of research indicates that expressed emotion [defined as criticism, hostility, and emotional over-involvement (23)] in the family of an individual with BD is associated with a higher level of manic symptoms (24) and an increased risk of relapse (25). Assessments of expressed emotion typically rely on third-party observations of family members during the Camberwell Family Interview (23) and do not take subjective experiences reported by patients into account. Measures of perceived criticism rely on the patient's subjective report but assess only one type of adverse social experience (e.g., they do not consider how overburdened or ignored the individual may feel). Thus, additional research is needed to determine whether social strain (i.e., the patient's perceptions of a range of adverse experiences in naturally occurring social interactions) is elevated in inter-episode BD and whether it is related to inter-episode instabilities in sleep and social rhythms.

Social support, social strain, and inter-episode instabilities in sleep and social rhythms

As already noted, studies of healthy, medically ill, and unipolar depressed individuals suggest that social support and social strain affect well-being (9, 12, 26). A body of research has also examined the influence of social support and aspects of social strain on BD illness course (13, 22, 24). However, the associations between social support, social strain, and the instabilities characteristic of interepisode BD have yet to be examined. Hence, the present study sought to examine the relationship between social support, social strain, and two factors known to be unstable and problematic in inter-episode BD: sleep and social rhythms. The rationale for the present study's focus on sleep and social rhythm instability, and for their proposed associations with social support and social strain, are now detailed.

A variety of studies have indicated that sleep and social rhythms are significantly and pervasively destabilized in BD. Indeed, disturbed sleep is characteristic of (hypo)manic and depressive episodes (27). Sleep has also been found to be disturbed and variable in inter-episode BD (4). Furthermore, there is evidence that sleep disturbance and variability are associated with past illness course (28) and are predictive of increased mood symptoms (29). Social rhythms, which are defined as regularly occurring activities (such as social contact and exercise) that help to entrain biological rhythms (6), also appear to be relatively unstable in BD. There is evidence that social rhythm instability is more common in individuals with BD than in healthy controls (30). Additionally, social rhythm instability has been found to

predict the time to onset of first hypomanic affective episode in a group considered to be at risk for developing BD (31) and may also increase the risk of relapse in those diagnosed with BD (5). Overall, the evidence suggests that instabilities in sleep and social rhythms are highly prevalent in BD and may increase vulnerability to experiencing future affective episodes. Thus, it is important to identify factors that could affect the stability of sleep and social rhythms. In that vein, two biopsychosocial models highlighting plausible bidirectional connections between sleep, social interactions, and interpersonal relationship quality have been proposed. First, Troxel et al. (32) have drawn attention to the social context of sleep, proposing a model whereby relationship quality and sleep quality are related in a bidirectional manner via chronobiological, behavioral, psychological, and physiological pathways. Their model is based on the premise that a feeling of safety and security is necessary for the experience of restful sleep (33), and suggests that poor marital relationships are associated with sleep disruption, while positive marital relationships are related to better-quality sleep. In addition to this model, which is focused on marital relationships, there is evidence to suggest that having more secure relationships overall is associated with better-quality sleep in both single and partnered individuals (34). Therefore, it is reasonable that sleep could be related to social support and social strain associated with an individual's overall social network.

Social zeitgeber theory (6) is another biopsychosocial model that proposes a connection between social relationship quality (e.g., social support) and stability in sleep and social rhythms. This theory posits that increased instability in social rhythms, which may be triggered by stressful events, leads to disturbances in sleep and, ultimately, to relapse among mood-disordered individuals. In a discussion of social zeitgeber theory, Frank and Swartz (35) postulate that higher levels of social support have the potential to decrease social rhythm instability in BD, particularly in the presence of a stressful life event. Aspects of social support have indeed been found to be related to social rhythm stability in a sample of widowed elderly individuals (36). However, the associations between social support, social strain, and social rhythm stability have yet to be assessed in BD.

Study aims

The aim of the present study was to further characterize social support and social strain in inter-episode BD. The first aim was to compare social support and social strain in inter-episode BD and control participants. It was hypothesized that *social support* reported by inter-episode BD participants would be *lower* than that reported by healthy controls. Moreover, *social strain* reported by inter-episode BD participants was hypothesized to be *higher* than that reported by controls. The second aim was to assess whether social support and social strain are associated with instabilities in sleep and social rhythms in inter-episode BD. It was hypothesized that higher levels of *social support* would be correlated with *less instability* in sleep and social rhythms. Additionally, higher levels of *social strain* were hypothesized to be associated with *greater instability* in sleep and social rhythms.

Methods

Overview

As part of a larger study, we enrolled 35 individuals diagnosed with inter-episode BD type I and 38 healthy controls. All participants completed a baseline visit, where diagnostic measures and measures of manic and depressive symptoms, perceived social support and social strain, and medication use were administered. As inter-episode BD instabilities in sleep and social rhythms were of interest, the BD group subsequently completed 28 days of daily diary assessments to capture information about sleep and social rhythms. Sleep was also assessed with 28 days of actigraphy. All participants in the BD and control groups returned to the laboratory for a second visit 28 days after the baseline visit and were reassessed for symptoms, social support, social strain, and medication use over the preceding month (i.e., the period during which sleep and social rhythms mood were assessed in the BD group).

Participants

Participants were recruited via online advertisements and flyers posted in the San Francisco Bay Area (San Francisco, CA, USA). Interested individuals completed a preliminary telephone screening interview with trained research assistants. In sum, 432 individuals were screened, 68 chose not to enroll or were unable to be reached subsequently, and 288 fell outside the inclusion criteria (specific details follow). The final sample consisted of 38 individuals in the control group and 35 individuals in the BD group (inter-episode instability data were collected from 33 BD group participants, as two dropped out following the first visit).

Inclusion criteria for the BD group were as follows: (i) BD type I (n = 35) diagnosis according to the Structured Clinical Interview for DSM–IV-TR (SCID) (37) (36 excluded for not meeting SCID criteria for BD type I); (ii) inter-episode status throughout the study as defined by the absence of a depressive or (hypo)manic episode according to the SCID, and rating at asymptomatic-to-mild symptom levels on the Clinician Rated Inventory of Depressive Symptomatology [(IDS-C) (38) score< 24] and the Young Mania Rating Scale [(YMRS) (39) score < 12] in the month preceding each study visit (14 excluded for not being inter-episode at the baseline visit, two excluded at the second visit and re-enrolled once symptoms returned to inter-episode levels); (iii) being under psychiatric care (requirement of the ethics committee; 19 excluded for not being under psychiatric care); (iv) no suspected diagnosis of substance or alcohol abuse disorder in the six months preceding the baseline visit (26 excluded for suspected substance / alcohol abuse); and (v) no suspected confounding sleep disorder, such as sleep apnea or restless leg syndrome, based on responses to the preliminary telephone interview and to the Duke Structured Interview for Sleep Disorders [(DSISD) (40)] (36 excluded for suspected confounding sleep disorder). Inclusion criteria for the control group were as follows: (i) no lifetime history of any form of Axis I disorder according to the SCID (91 excluded on this basis) and (ii) no subjective sleep complaints according to the DSISD (29 excluded on this basis). Additionally, individuals were excluded from either participant group for: (i) history of a major head

trauma or severe progressive medical illness (29 excluded on this basis) and (ii) having no stable living arrangement (11 excluded on this basis).

Demographic characteristics of the participants were representative of the San Francisco Bay Area (see Table 1). As BD is typically associated with the presence of comorbid psychiatric diagnoses (1), participants in the BD group were not excluded on the basis of comorbid diagnoses other than alcohol or substance abuse disorders. Current comorbidities included panic disorder (n = 3), social phobia (n = 3), specific phobia (n = 6), posttraumatic stress disorder (n = 1), generalized anxiety disorder (n = 5), and eating disorder not otherwise specified (binge eating; n = 2). Additionally, because studying a medication-free sample of BD participants for a month-long duration is unfeasible and unrepresentative, participants in the BD group were not required to be medication free. The majority of the BD group reported taking at least one psychotropic medication (n = 26), which included mood stabilizers (n = 9), antidepressants (n = 14), and antipsychotic agents (n = 20).

Measures

Diagnosis and symptoms—Psychiatric diagnosis was determined for both groups at the baseline visit using the SCID. The IDS-C and YMRS were administered at each study visit to assess, respectively, depressive and manic symptoms in the preceding month. This approach yielded symptom data for the month preceding the baseline visit and for the month during which sleep, social rhythms, and mood were assessed in the BD group. The IDS-C total score is based on 28 items with scores ranging from 0 to 84. Scores lower than 24 indicate that depressive symptoms are in the asymptomatic to mild range. The IDS-C has good psychometric properties and is widely used in medical and research settings (38). The YMRS consists of 11 items with scores ranging from 0 to 60. Scores lower than 12 indicate that (hypo)manic symptoms are in the asymptomatic to mild range (41). The YMRS has good inter-rater reliability and predictive validity (39).

To assess diagnostic inter-rater reliability, independent coders scored a randomly selected sample of SCID (n = 17) and IDS-C and YMRS interviews (n = 42). Primary diagnoses on the SCID matched those made by the original interviewer in all cases (k = 1.00). Inter-rater reliability on the IDS-C (n = 42; ICC = 0.90) and YMRS (n = 42; ICC = 0.84) was also high.

Social support—Social support was assessed at each study visit using the Interpersonal Support Evaluation List (ISEL) (42). The ISEL is a 40-item self-report measure rated on a scale ranging from 1 to 4, with higher total scores reflecting greater perceived social support. The ISEL assesses support in four domains: tangible assistance (financial / tangible support), self-esteem (supportive actions by others that impart the individual with a sense of being lovable, valuable, and capable), appraisal (presence of others with whom problems can be discussed), and belonging (presence of others with whom one can engage in social activities). The ISEL has good psychometric properties ($\alpha = 0.86$, test–retest reliability = 0.87) (42) and has been used in studies of BD (43). In the present study, the total ISEL score was of interest, and internal consistency for the overall measure was high ($\alpha = 0.94$).

Social strain—Social strain was assessed using the Inventory of Negative Social Interactions (INSI) (20). The INSI is a 40-item self-report measure that assesses various

types of adverse social experiences (e.g., being criticized, ignored, and left out). The frequency with which these events have taken place in the preceding month are rated using a 1 to 5 scale, with higher total scores corresponding to greater social strain. The INSI is psychometrically sound [$\alpha = 0.92$, test–retest reliability = 0.68 (20)]. High internal consistency was found in the present study ($\alpha = 0.95$).

Sleep—Sleep instability was assessed via subjective (i.e., diary) and objective (i.e., actigraphy) estimates. To gather subjective data, BD group participants reported their bedtime, arising time, and amount of wakefulness over the course of the preceding night on each morning of the daily diary. This information was used to calculate nightly total sleep time in minutes (*TST–diary*). Subjective sleep estimates are an important indicator of the individual's perceived sleep quality and are part of the gold standard assessment of sleep disorders (44).

To gather an objective estimate of sleep, BD group participants wore an actigraphy watch (Mini Mitter AW64 Actiwatch Inc., Bend, OR, USA) continuously for 28 days. The actigraphy watch assesses wake / sleep times and activity levels by measuring movement (sampled in 60-sec epochs). Data are stored in the watch's embedded miniaturized piezoelectric acceleration sensor. These data are downloaded and used to estimate sleep onset and offset. To increase the accuracy of sleep onset and offset estimates, study participants were asked to press a button on the actigraphy watch just before attempting to initiate sleep and immediately upon arising in the morning. Nightly total sleep time in minutes (*TST–actigraphy*) was calculated by trained graduate students using Respironics Actiware Version 5.5 (Copyright 2004–09, Respironics Inc., Murrysville, PA, USA) in conjunction with information gathered from button presses and daily diaries. The following procedure was developed by our group for sleep scoring: if the button press occurred within 10 min of the sleep onset / arising time as coded by the Respironics Actiware software, the time registered by the button press was used to set the sleep onset / arising time. If the button press did not occur within 10 min of the sleep onset / arising time as coded by the software, the time reported on the sleep diary was used to set the sleep onset / arising time. Finally, if neither button press nor diary data was available, automatic settings by Respironics Actiware software were used to set sleep onset / arising time. All cases were discussed among the coders in order to ensure consensus in scoring. Nights when participants indicated removing the watch were excluded from analysis. Seven participants had one or more nights excluded for this reason, with a total of 13 nights across all participants excluded due to the watch having been removed. Sleep assessed via actigraphy is strongly correlated with sleep assessed via polysomnography (45). Actigraphy has been validated in clinical samples (46) and has been used in studies of individuals with BD (47). It is ideal for the naturalistic assessment of sleep instability, as it is non-invasive and capable of storing large amounts of continuously collected data.

Social rhythms—To assess social rhythms, BD group participants completed the Social Rhythm Metric (SRM) (48) on the daily diary each evening over the 28 days between the baseline and second study visits. The SRM measures daily activity and social contact. It has been validated in healthy and depressed individuals (48) and has been used in studies of BD

(30). The SRM consists of a list of 14 activities that may be completed over the course of a day (e.g., going outside for the first time, having lunch, etc.). Each evening, participants indicated the time they completed the activities, if applicable. The SRM algorithm (48) was used to calculate weekly SRM scores, which were averaged for the diary month to yield a measure of social rhythm instability over the 28 days of the study. Scores range from 0 to 7, with higher scores indicating greater social rhythm stability. Additionally, in order to assess the social context in which daily activities were completed, participants were asked to indicate whether each activity was done alone, with the subject's spouse, with children, with other family members, or with non-family persons. These data were coded to yield a percentage over the month for the number of activities completed in each of these social contexts.

Medication status—In order to assess medication regimen adequacy in the BD group, participants reported the names and dosages of their medications and indicated when and how often they had taken these medications in the 28 days preceding the second laboratory visit (i.e., during the period of sleep and social rhythm assessment). Information gathered through this report was coded using the Somatotherapy Index (49). This six-point scale was designed to assess treatment adequacy in mood disorders, with higher scores indicating a more intense medication regimen, taking into account the dose and class of each medication in combination with each other. The Somatotherapy Index score is obtained by: determining the type and dose of all medications that participants report taking; coding each as an antidepressant, lithium, valproate, carbamazepine, or an alternative therapy (this category includes gabapentin and lamotrigine among other agents); and then calculating the Somatotherapy Index score by combining category levels (e.g., based on the following coding system: if a lithium level is coded as a 1 and the alternative therapy level is coded as a 4, the Somatotherapy Index score is a 4). The level of each coded category is scored on a scale of 0 to 4, based on dose or number of therapies. In order to rate the level of lithium, valproate, or carbamazepine higher than a 1, blood serum levels of the medications are required. Therefore, in the present study, the antidepressant and alternative treatment subscales were coded on a scale ranging from 0 to 4 (low to high dose /number of therapies), and mood stabilizer subscales were rated dichotomously (treatment is absent or present) because blood serum levels for these medications were not available. Levels of antipsychotic agent were coded separately and were not considered when calculating the overall Somatotherapy Index score. The Somatotherapy Index is reliable and has been used in BD samples (50).

Procedures

The University of California's Committee for the Protection of Human Subjects approved all study procedures. Interested individuals responding to recruitment postings completed a preliminary screening interview over the telephone. Callers appearing to be potentially eligible for either the BD or control group were invited to the lab for a baseline visit. At this visit, participants signed informed consent and completed the SCID, DSISD, IDS-C, YMRS, ISEL, INSI, and demographics and medication questionnaires. Next, because the study aimed to assess the crosssectional association between social support, social strain, and instabilities in sleep and social rhythms in inter-episode BD, eligible participants with BD

were invited to participate in 28 days of diary and actigraphy assessments. They were asked to call the laboratory each time they completed the morning (sleep) and evening (social rhythms) portions of the diary, to ensure timely completion of diary entries. Participants who missed three consecutive calls were contacted by study staff and encouraged to resume calling. An average of 88% of participant calls were completed as requested. At the end of the 28 days, all BD and control group participants returned to the laboratory for a second study visit, where the YMRS, IDS-C, ISEL, INSI, and the medication questionnaire were administered.

Data analysis

Following recent discussions of affective instability indexes (51), the mean square successive differences (MSSD) (52) of TST–diary and TST–actigraphy were calculated to reflect sleep instability. The MSSD assesses instability in time series data as defined by variability in amplitude and frequency of changes in scores. It was chosen as the measure of sleep instability based on its past use in experience-sampling studies of mood in clinical populations (53).

Two BD group participants chose not to continue participating after the first visit. Thus, their data were included only in the social support and social strain group comparisons. Four BD participants were missing more than 20% of their diary or actigraphy data; these missing data were replaced by the group means. One participant in the BD group did not complete the INSI at the second visit; the average INSI score for the overall sample was substituted for this missing value. Additionally, three participants in the BD group did not provide medication data; the average and modal responses for the sample were substituted for the missing data. Finally, of the 33 BD participants who completed the 28 days of SRM assessment, six participants did not consistently indicate with whom they completed each of their daily activities. Thus, analyses examining associations between social support, social strain, and social context of daily activities were based on a total sample of 27 participants. There were no differences in ISEL score, INSI score, or first or second visit symptoms between participants who were missing data and those who were not.[1]

Variable distributions were examined to determine if normality assumptions had been met. Distributions of MSSD TST–actigraphy and INSI score at the second visit were positively skewed and leptokurtic. These variables were natural logarithm transformed and were subsequently found to be normally distributed. Analyses by *t*-tests and chisquare tests were then used to assess for differences in demographic characteristics and symptoms between the BD and control groups.

A multivariate analysis of variance (MANOVA) was used to address the first and second hypotheses by comparing social support and strain in the BD and control groups. In testing the first and second hypotheses, total ISEL (social support) and INSI (social strain) scores averaged across the two laboratory visits were used, with the rationale that these capture

[1]Analyses that involved sleep data were repeated without using group means to replace missing data. The results are presented as footnotes.

perceptions of social support and social strain over a longer duration than scores obtained at either single time point.

A series of correlations (six in total) was used to address the third and fourth hypotheses by measuring cross-sectional associations between social support and social strain, and sleep and social rhythm instabilities in the BD group. In testing the third and fourth hypotheses, total ISEL and INSI scores obtained at the second laboratory visit were used, with the rationale that these scores reflect social support and social strain perceived over the 28 days of diary and actigraphy assessment. An additional set of correlations was used to assess whether social support and social strain at the first visit were correlated with sleep and social rhythm instability in the subsequent month.

Results

Participant characteristics

Table 1 presents the demographic characteristics and mood symptom data for the BD and control groups as well as information on illness history, medication status, and sleep and social rhythm instabilities in the BD group. The average Somatotherapy Index score in the BD group was fairly low (mean = 1.69, standard deviation = 1.43), in part because blood serum levels for mood stabilizers were not available for calculating scores. As evident in Table 1, the BD and control groups were matched on demographic variables (including age, gender, income, and employment status) other than marital status and race. Additionally, while all participants were inter-episode over the course of the study, the BD group had significantly higher levels of depressive and manic symptoms at all study points.

Social support and social strain in the BD and control groups

Social support and social strain were not correlated in the overall sample ($r = -0.15$, n = 73, $p > 0.10$). A MANOVA was used to assess control versus BD group differences in social support (average ISEL score over the course of the study) and social strain (average INSI score over the course of the study). As the BD group had a significantly greater proportion of white and unmarried participants than the control group, race and marital status were included as covariates in the analysis. A significant omnibus group effect was present in the MANOVA [$F(1,68) = 7.09$, $p < 0.01$]. As evident in Table 2, the BD group had lower social support and higher social strain compared to the control group after accounting for group differences in the proportion of white and unmarried participants.

In the initial analysis, symptoms were not included as covariates, following the argument put forward by Miller and Chapman (54).[2] The analysis was repeated to explore the potential role of manic and depressive symptoms. A MANOVA with group as a fixed factor, race and marital status as covariates, and the additional inclusion of average YMRS and IDS-C score as covariates was used. In this analysis, there was no longer a significant omnibus effect for group [$F(2,66) = 1.13$, $p > 0.10$].

[2]These authors argued against statistically controlling for symptoms in psychopathology research when group status (e.g., BD versus control) cannot be randomly assigned. Depressive and hypomanic symptoms are a core feature of the inter-episode period of BD (55). Thus, statistically controlling for them is likely to remove meaningful variance and potentially obscure key group differences (54).

Correlations of symptoms (averaged over the first and second visit) with social support and social strain (averaged over the first and second visit) were examined in the BD group. Average social strain over the course of the study period was associated with average manic symptoms ($r = 0.46$, n = 35, $p < 0.01$) and average depressive symptoms ($r = 0.36$, n = 35, $p < 0.05$) over the study period. Social support was not correlated with manic or depressive symptoms (all $p > 0.10$).

The potential temporal associations between social strain and symptoms in the BD group were further assessed with four regression analyses – two examining the relationship between strain and manic symptoms, and two examining the relationship between strain and depressive symptoms. With respect to social strain and manic symptoms, a model using social strain at the first visit as a predictor of manic symptoms at the second visit after controlling for manic symptoms at the first visit was not significant [$F(2,30) = 3.29$, $p > 0.05$; $R^2 = 0.18$]. A model using manic symptoms at the first visit as a predictor of social strain at the second visit after controlling for social strain at the first visit was significant [$F(2,30) = 7.79$, $p < 0.005$; $R^2 = 0.30$]. However, manic symptoms at the first visit did not account for a significant proportion of the explained variance in the model ($\beta = 0.17$, $t = 1.09$, $p > 0.10$). With respect to social strain and depressive symptoms, a model using social strain at the first visit as a predictor of depressive symptoms at the second visit after controlling for depressive symptoms at the first visit was not significant [$F(2,30) = 1.06$, $p > 0.10$; $R^2 = 0.07$]. A model using depressive symptoms at the first visit as a predictor of social strain at the second visit after controlling for social strain at the first visit was significant [$F(2,30) = 6.91$, $p < 0.01$; $R^2 = 0.32$]. However, depressive symptoms at the first visit did not account for a significant proportion of the explained variance in the model ($\beta = -0.004$, $t = -0.29$, $p > 0.10$).

Social support, social strain, and inter-episode instabilities in the BD group

Before testing hypotheses related to inter-episode instabilities in the BD group, demographics, medication status, illness history, and symptom levels in the inter-episode BD group were examined to assess whether they represented potential confounding variables. No variable was found to be associated with both a dependent and an independent variable of interest. Thus, none of the examined variables was believed to be a confound, and no covariates were included in the analyses.

To test the hypothesis that social support would be correlated with instabilities in sleep (MSSD of TST–diary and MSSD of TST–actigraphy) and social rhythms (SRM score), a set of three correlations was used. There was a significant correlation between ISEL score at the second visit and MSSD of TST–actigraphy ($r = -0.38$, n = 33, $p < 0.05$),[3] indicating that higher levels of social support were associated with more stable sleep as assessed via actigraphy. There were no other significant findings, as social support was not related to MSSD of TST–diary ($r = -0.11$)[4] or SRM score ($r = 0.02$). To test the hypothesis that social strain would be correlated with instability in sleep and social rhythms, an additional three

[3]This correlation remained significant when participants with missing actigraphy data were excluded from the analyses ($r = -0.38$, n = 31, $p < 0.05$).

[4]The same correlation was obtained when participants with missing diary data were excluded from the analyses ($r = 0.11$, n = 31).

correlations were used. There were no significant findings, as social strain was not correlated with MSSD of TST–diary ($r = 0.19$), MSSD of TST–actigraphy ($r = -0.01$), or SRM score ($r = -0.13$).[5] In order to explore possible temporal associations between social support, social strain, and inter-episode instabilities, correlations between social support and social strain at the first visit and instabilities in the subsequent month were assessed. There were no significant findings.

To further explore associations between the social context of activities and overall social support and strain, post-hoc correlations between social support and strain at the second visit and the percentage of daily activities completed alone, with the subject's spouse, with children, with other family, and with non-family persons were examined. Social strain was negatively correlated with the percentage of activities completed with the subject's spouse ($r = -0.41$, $n = 27$, $p < 0.05$). No other correlation between social support, social strain, and social context of activities was significant at a level of $p < 0.05$.

Discussion

The overarching goal of the present study was to further characterize social support and social strain in inter-episode BD. The first aim was to compare social support and social strain in inter-episode BD and control participants. The results supported the hypothesis that inter-episode BD would be associated with lower social support compared to controls. This is consistent with past findings of deficient social support in a sample of women diagnosed as inter-episode BD type I (16). The present study replicated and extended these findings to a diverse sample of inter-episode BD men and women. The fact that Staner and colleagues (17) did not find BD to be associated with deficient social support likely relates to differences in measures. The present study and that by Romans and McPherson (16) both emphasized *perceived* social support, while the measure used by Staner and colleagues (17) is more consistent with an *objective* (i.e., quantitative) social support measure. In sum, as in unipolar depression (56), it appears that the *perceived* quality of social relationships rather than the number of available support providers is lacking in men and women with inter-episode BD.

The hypothesis that inter-episode BD would be associated with a higher level of social strain compared to the control group was also supported. To the best of the authors' knowledge, this is the first study to have assessed social strain in BD. Interestingly, social strain in the BD group was positively correlated with manic and depressive symptoms, while social support was not correlated with symptoms. Analyses examining the prospective association between social strain and manic symptoms indicate that strain does not predict manic symptoms after controlling for baseline manic symptoms, and that manic symptoms do not predict social strain after controlling for baseline social strain. The same pattern was found for social strain and depressive symptoms: strain did not predict depressive symptoms after controlling for baseline depressive symptoms, and depressive symptoms did not predict social strain after controlling for baseline social strain. This suggests that mood symptoms

[5]When participants with missing data were excluded from the relevant analyses, social strain continued not to be significantly correlated with MSSD of TST–diary ($r = 0.17$, $n = 30$), MSSD of TST–actigraphy ($r = -0.10$, $n = 30$), or SRM score ($r = -0.07$, $n = 32$).

and social strain may be related in a bidirectional manner, such that more symptomatic individuals perceive a higher level of social strain, while social strain exacerbates symptoms. The possibility of a bidirectional relationship between strain and symptoms is consistent with previous suggestions that individuals with BD who are more symptomatic generate more strain in their relationships (57). The present results are also consistent with findings that individuals with BD whose families are characterized by more expressed emotion experience more manic symptoms (24), and that individuals with BD who experience greater distress associated with perceived criticism are at an increased risk of experiencing depressive symptoms (22). This suggests that attending to social strain in future studies of social relationships in BD may be particularly important. A longer follow-up period may allow for stronger conclusions regarding the direction of influence between strain and symptoms to be made.

It is noteworthy that group was not a significant predictor of social support and social strain once symptom levels were entered as covariates. This suggests that inter-episode symptoms may account for the lower levels of social support and higher levels of social strain found in the BD group compared to the control group. As symptoms are a core feature of the inter-episode period of BD(55), it is not surprising that they would account for a significant portion of the variance initially explained by the BD diagnosis. Indeed, perhaps it is not the BD diagnosis itself but rather persistent inter-episode symptoms (2, 3) that are associated with the deficient social support and increased social strain reported by individuals with BD. These results are consistent with previous findings of widespread impairment in inter-episode BD (7) and suggest that inter-episode symptoms are significantly related to social support and social strain in this illness.

The second study aim was to assess whether social support and social strain in inter-episode BD are associated with instabilities in sleep and social rhythms. In support of the hypotheses, cross-sectional analyses indicated that greater social support was associated with more stable sleep as assessed with actigraphy. This is consistent with, and expands on, the biopsychosocial model of sleep (32), which states that better quality sleep is associated with better-quality marital relationships. Interestingly, although support and sleep instability were correlated in cross-sectional analyses, social support at the first visit was not correlated with sleep instability in the subsequent month. This may be due to the fact that it was not possible to control for sleep instability present at the time of the first social support assessment. Nevertheless, the findings suggest that social support may not independently predict future sleep instability in BD. Instead, it may be the case that social support and sleep instability are related in a bidirectional manner or that sleep instability contributes to decreased social support. This is an important issue for future research, as the present study design did not allow us to examine whether sleep instability predicted social support, thereby precluding conclusions regarding causality. It should be noted that the cross-sectional association between social support and sleep instability in the present study was found for actigraphy but not diary. This is not surprising, as discrepancies between subjective and objective estimates of sleep have previously been reported across a range of disorders (58). Discrepancies between subjective and objective sleep estimates may occur for a number of reasons, including possible sleep misperception, the fact that sleep onset and duration are difficult to perceive and remember accurately (59), and the possibility that

actigraphy does not allow us to capture more subtle sleep disturbances that are present in BD (58). Additionally, subjective and objective measures may reflect different aspects of sleep disturbance, such that stability in the amount of sleep obtained is associated with social support but one's perceptions of sleep stability is not. Thus, our findings are consistent with previous literature in highlighting that both subjectively and objectively estimated parameters are needed for a comprehensive assessment of sleep, particularly in sleep-disordered samples (44).

It was also hypothesized that social support and social strain in the inter-episode BD group would be associated with instabilities in social rhythms. These hypotheses were not supported. There are a number of possible explanations. First, the hypotheses were based on social zeitgeber theory (6, 35), which proposes that social support helps to stabilize social rhythms in BD. However, the theory specifically focuses on this stabilizing effect in the context of life stress, which was not measured in the present study. Future studies that examine the role of life stress in this model may help to clarify whether social support and social strain affect social rhythm stability in the context of heightened stress. Second, social support and social strain may not be directly related to social rhythm stability because regular and stable occurrences in an individual's life may involve adverse social experiences (e.g., dinner may occur nightly at 7:00 p.m., but it may also involve family members criticizing the BD individual). Our finding that completing more activities with the subject's spouse was associated with less social strain suggests that there may be a relationship between the consistent presence of a specific individual and overall social strain. As these are correlational data, it is not possible to determine whether spending time with one's spouse leads to decreased strain or vice versa. Additionally, knowing that a particular person was present when an activity was completed still does not allow us to know whether the activity was a positive or negative experience for the patient. Thus, we hope that future research will build on the present methodology by assessing the quality of the specific activities comprising one's social rhythms. This may be a useful next step in elucidating whether support and strain have a stabilizing / destabilizing effect on these rhythms in inter-episode BD.

A number of potential limitations of the present study should be noted. First, the sample size was relatively small, thereby limiting the power to detect significant effects. Specifically, the analyses focused on instabilities in the BD group were somewhat under-powered, as power was sufficient to detect only relatively large effect sizes ($r = 0.23$ or higher). The study's focus on inter-episode BD by definition restricted range in symptom measures. Thus, a larger sample may have led to more findings reaching statistical significance, particularly in analyses concerned with symptoms in the BD group. Second, no correction was made for multiple comparisons, which increases the risk of type I error. However, decreasing the risk of type II error (58) was a concern, as associations between social support / strain and inter-episode BD instabilities have not been previously examined. Consequently, we chose not to correct for multiple comparisons in order to maximize the information gleaned from this initial study. Third, the BD and control groups were not matched on racial composition or marital status. Although group differences in support and strain remained after controlling for these variables, it will be important for the present results to be replicated in samples that

are more closely matched in their demographic composition. Fourth, this study was a first step toward investigating potential associations between social support, social strain, and interepisode instabilities in BD. The use of prospective longitudinal designs in future research is needed to more thoroughly examine temporal associations between support / strain and BD symptoms and instabilities. This would be particularly useful in further assessing the potential bidirectional relationship between social strain and mood symptoms suggested by the present findings. A larger sample followed longitudinally would likely yield data with greater fluctuations in social strain, depressive symptoms, and manic symptoms, which may help to illuminate the manner in which strain and symptoms are related over time. Fifth, as participants recorded information about their daily social rhythms each evening, the data may have been subject to recall bias (60). Although timely response and call-in rate were excellent (88% on average), it may be helpful to use hand-held data-logging devices in future studies. Sixth, we aimed to assess the relationships between social support, strain, and sleep and social rhythms in an interepisode BD type I sample while setting inclusion / exclusion criteria designed to control for potential confounds. Consequently, the present study findings may not generalize to individuals with BD with comorbid sleep disorders, current substance / alcohol abuse, chronic medical conditions, histories of head trauma, no psychiatric care, or no stable housing. Seventh, the measure used to assess medication adequacy is a self-report measure. The accuracy of medication data would be enhanced with the use of blood serum level testing and / or checking medications with prescribing physicians in future studies. Finally, a number of medications taken by the BD participants have potential sedating / alerting side effects. We elected not to control for these effects for a number of reasons. Most BD participants reported treatment with polypharmacy, and there is insufficient statistical power to examine the potential effects of each medication combination in the present study. Furthermore, it is not possible to determine what interaction effects may be exerted by the medication combinations. Additionally, a number of medications taken by our participants can have both an alerting and sedating side effect. Lastly, as noted by Talbot and colleagues (61), a minority (4–37%) of individuals with BD experience sleep-related side effects, and it is not possible to determine which of our participants were experiencing sedating / alerting effects. Although we have elected not to examine the potential confound of medication sleep effects, it is important to note that no measure of medication status was associated with sleep instability variables in the present study.

In conclusion, the results indicate that social support and social strain represent clinically relevant psychosocial factors that significantly impact the lives of individuals with inter-episode BD. Specifically, the present study expanded on past work to suggest that social support is deficient in inter-episode BD men and women of diverse backgrounds. Additionally, social strain was found to be elevated and significantly correlated with inter-episode manic and depressive symptoms in the BD group, suggesting that it may play a particularly important role in BD that is separate from that played by social support. Furthermore, the association between social support and sleep instability in the inter-episode BD group suggests that social support may help to stabilize key biological rhythms in this population. Given the potential theoretical and clinical implications of these findings,

incorporating measures of social support and social strain in longitudinal studies of BD is an important goal for future research focused on this chronic and impairing disorder.

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Table 1

Demographics, illness history, medication status, mood symptoms, and inter-episode instability in the bipolar disorder and control groups

	Controls (n = 38)	Bipolar disorder (n = 35)	χ^2 or *t*-test
Demographics			
Age, years	32.85 (12.91)	34.66 (10.03)	−0.52
Gender (% female)	51.3	57.1	1.66
Marital status (%)			12.10[a]
Single	56.4	68.6	—
Married / live-in partner	35.9	5.7	—
Divorced / separated / widowed	7.7	25.7	—
Race (% white)	35.9	62.9	4.93[a]
Income (% < $50000)	64.1	71.4	0.57
Employed (%)	76.9	54.3	3.93
Illness history			
Age at illness onset, years	—	18.03 (7.02)	—
Total past manic episodes	—	8.52 (15.45)	—
Total past depressive episodes	—	8.68 (11.68)	—
History of psychiatric hospitalizations (%)	—	55.9	—
No. of psychiatric hospitalizations	—	1.91 (2.96)	—
History of psychosis (%)	—	50.0	—
Medication status at second visit			
Somatotherapy score	—	1.73 (1.48)	—
Antidepressant treatment level	—	1.39 (1.58)	—
Alternative treatment level	—	0.37 (0.47)	—
Mood stabilizer treatment present (%)	—	27.3	—
Mood symptoms			
YMRS baseline visit	0.92 (1.36)	3.24 (2.97)	−4.25[a]
IDS-C baseline visit	2.30 (2.09)	8.70 (4.55)	−7.76[a]
YMRS second visit	1.11 (1.56)	3.92 (3.81)	−4.13[a]
IDS-C second visit	3.16 (3.03)	11.39 (5.59)	−7.77[a]
Average YMRS	1.03 (1.23)	3.37 (2.53)	−5.03[a]
Average IDS-C	2.74 (2.26)	9.95 (3.90)	−9.82[a]
Inter-episode instability variables			
MSSD of TST–diary (min)	—	16219.69 (8353.46)	—
MSSD of TST–actigraphy (min)	—	13029.83 (8318.51)	—
SRM average score	—	2.79 (0.68)	—

Values are reported as mean (standard deviation) unless indicated otherwise.

IDS-C = Clinician Rated Inventory of Depressive Symptomatology; MSSD = mean square successive difference; SRM = Social Rhythm Metric; TST–diary = total sleep time on diary (min); TST–actigraphy = total sleep time on actigraphy (min); YMRS = Young Mania Rating Scale.

[a] $p \leq 0.05$.

Table 2

Social support and social strain in the bipolar disorder and control groups after controlling for race and marital status

	Bipolar disorder (n = 35) Est. marginal mean (SE)	Controls (n = 38) Est. marginal mean (SE)	*F*
Social support (ISEL)	89.05 (2.45)	98.62 (2.35)	7.67[a]
Social strain (INSI)	17.75 (1.95)	10.20 (1.87)	7.55[a]

Est. = estimated; INSI = Inventory of Negative Social Interactions (average score over first and second visit); ISEL = Interpersonal Support Evaluation List (average score over first and second visit); SE = standard error.

[a] $p \leq 0.01$.